Adsorption Dynamics of C-5-C-6 Isomerate Fractions in Zeolite Beta for the Octane Improvement of Gasoline

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Abstract: An experimental and modeling study of the vapor-phase adsorption of C-5-C-6 paraffin fractions in a fixed bed of zeolite beta was addressed. Breakthrough experiments with mixtures containing n-pentane (nPEN), iso-pentane (iPEN), n-hexane (nHEX), 3-methylpentane (3MP), 2,3-dimethylbutane (23DMB), and 2,2-dimethylbutane (22DMB) demonstrate that the sorption hierarchy is temperature-dependent. At the optimum temperature of 583 K, an enriched high-octane molecule fraction of 22DMB, iPEN, and 23DMB can be selectively separated from the low-octane equimolar C-5-C-6 isomerate feed. For the case of feed mixtures with the typical composition of the hydroisomerization reactor product of the total isomerization process, the enriched fraction contains low research octane number (RON) nPEN, which decreases the octane quality of the product obtained. However, the use of a layered bed with zeolite 5A and zeolite beta can displace the nPEN from the enriched fraction, resulting in a maximum octane number of about 92.5 points. Aspen Adsim was used to simulate the dynamic behavior of the C-5-C-6 fraction in a non-isothermal and non-adiabatic bed, giving a good description of the set of experimental data. An optimal design of a mono/dibranched separation process can be achieved by properly tuning the operating temperature and the zeolite 5A/zeolite beta ratio on a layered fixed bed.
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